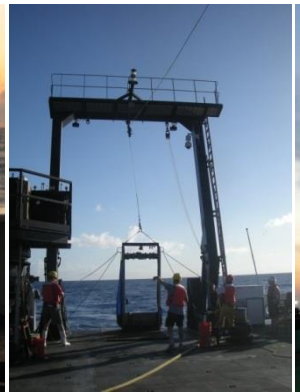
Collaborations between AOML and the NOAA-SEFSC Early Life History Lab: Past, present and future

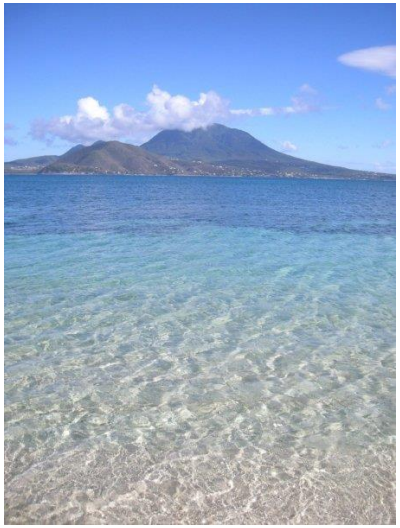
NOAA SEFSC ELH: Barbara Muhling, John Lamkin, Trika Gerard, Estrella Malca
NOAA AOML: Yanyun Liu, Sang-Ki Lee, Ryan Smith, Libby Johns, Rick Lumpkin
And
Frank Muller-Karger, Mitch Roffer, Joe Quattro, Walter Ingram, Lourdes Vasquez, Laura Carillo, Eloy Sosa-Cordero

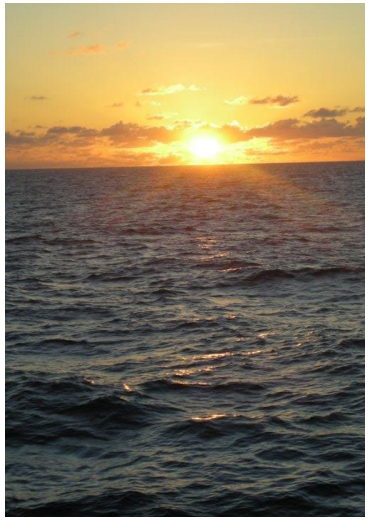
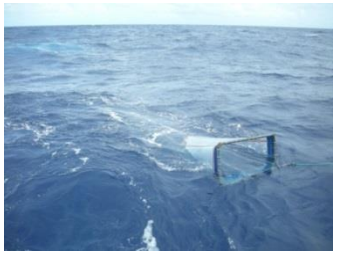





Some selected collaborations between NOAA-SEFSC-ELH and AOML

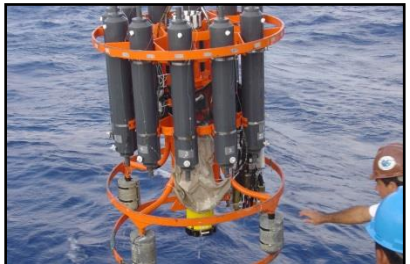
1) Mesoamerican Reef transport and ecology project
2) US Virgin Islands larval reef fish supply study
3) Climate change impacts on Atlantic tunas and billfishes

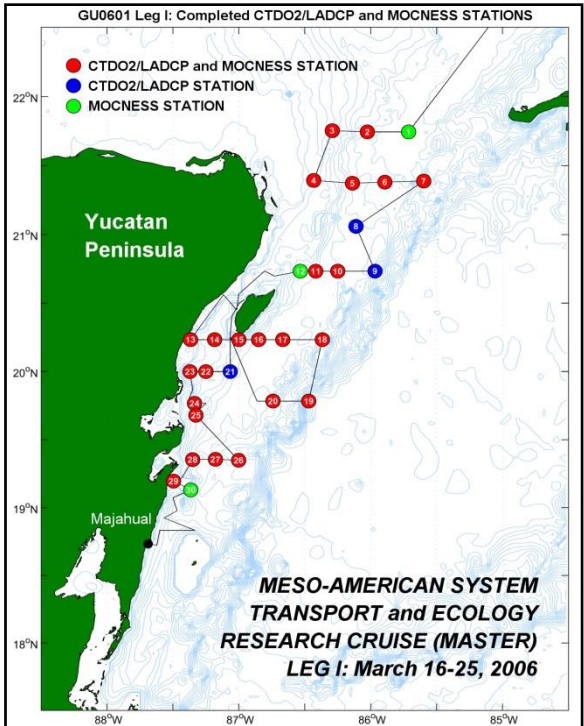



Mesoamerican Reef transport and ecology project

- *Aims*
  - To survey the larval distribution and physical oceanography of the western Caribbean
- *Time period*
  - Two cruises: March 2006 and January 2007
- *What we did*
  - Completed biophysical sampling including
    - Plankton tows for larval fishes
    - CTD casts, drifters and ADCP
- *Organizations*
  - AOML
  - SEFSC
  - University of Miami
  - ECOSUR (Mexico)
  - CINVESTAV (Mexico)
- *Further reading*
  - Muhling, Barbara A., Ryan H. Smith, Lourdes Vásquez–Yeomans, John T. Lamkin, Elizabeth M. Johns, Laura Carrillo, Eloy Sosa-Cordero, and Estrella Malca (2013) "Larval fish assemblages and mesoscale oceanographic structure along the Mesoamerican Barrier Reef System." *Fisheries Oceanography* 22: 409-428





Field Sampling

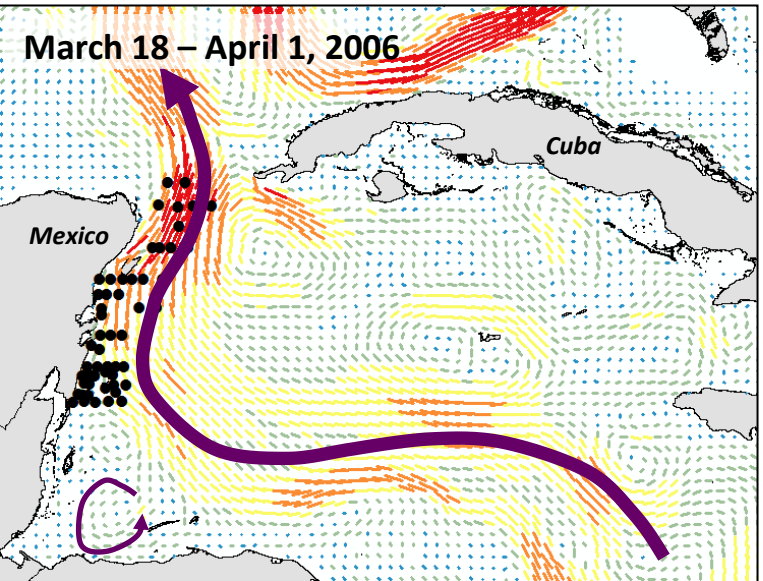
- We sampled along the eastern coasts of Mexico and Belize in 2006 and 2007
- In both years, the Caribbean Current impinged on the Yucatan Pensinula near the Mexico-Belize border, before turning north to become the Yucatan Current
- Larval fish collected within the Caribbean/Yucatan Current were mostly from mesopelagic (deepwater) families
- Larvae from waters inshore of the strongest flow were more likely to be from reef-associated taxa

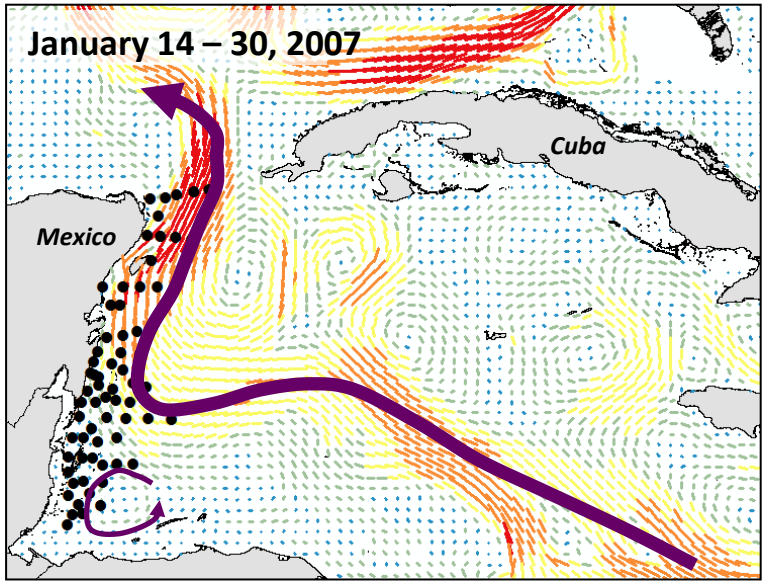
Bristlemouth (Gonostomatidae)

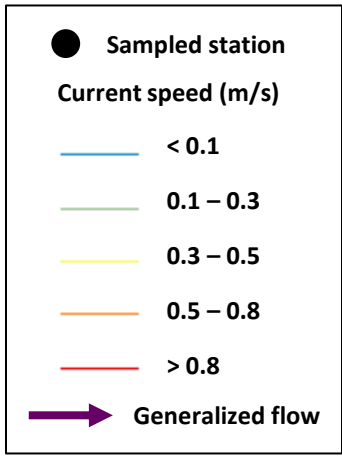
Lanternfish (Myctophidae)

Grouper (Serranidae)

Parrotfish (Scaridae)

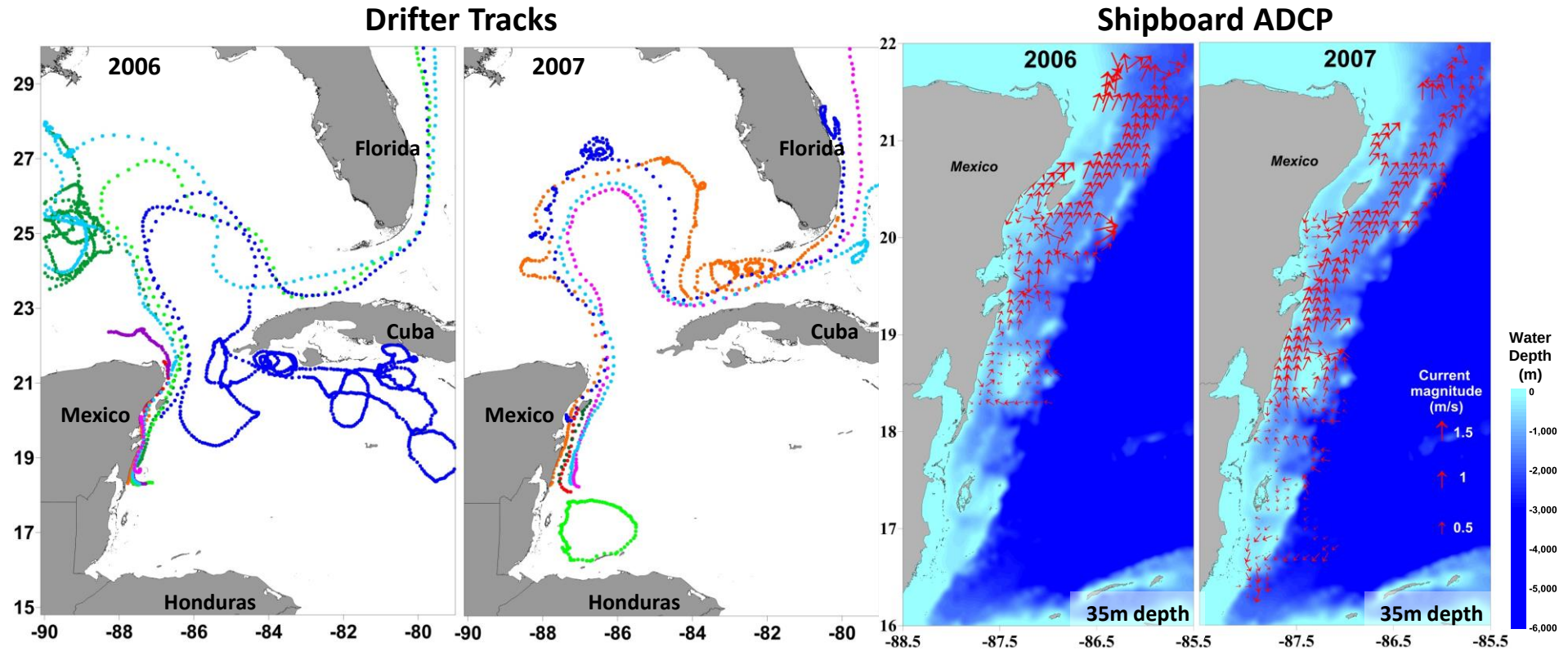






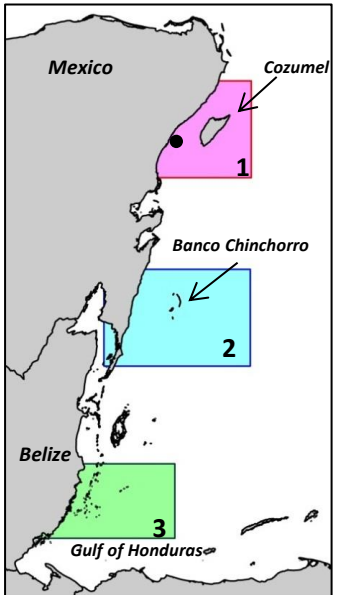
Drifter Tracks and Retention Conditions

- Tracks from drifters released during the cruises suggested that retention conditions for pelagic fish larvae could vary widely
- Shipboard ADCP showed strong northwards flow within the Yucatan Current, with localized retention areas
- To investigate further, we used historical drifter data from the AOML-PhOD Global Drifter Program



Historical Analysis

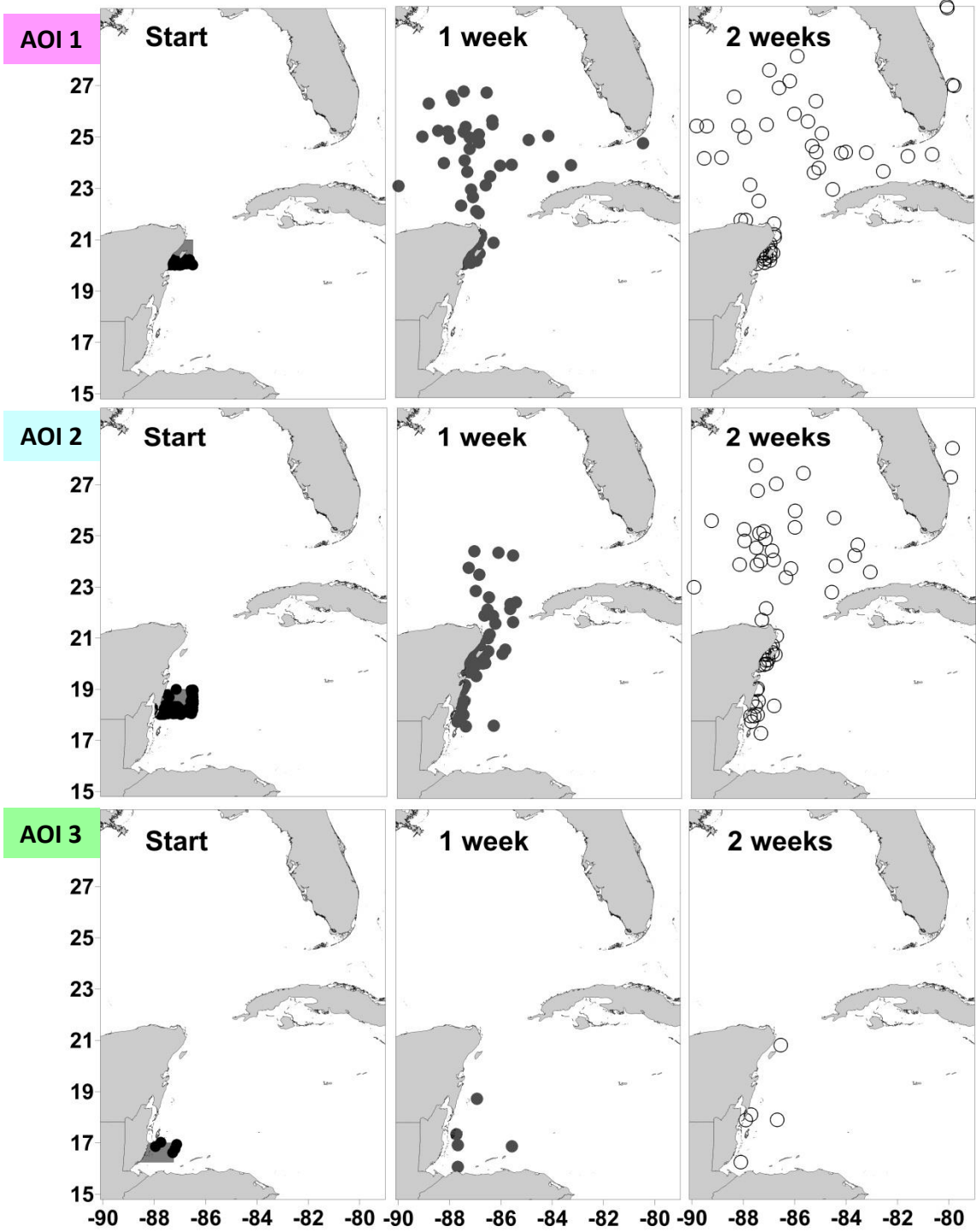
- All drifters passing through three areas of interest between 1979 and 2011 were “tagged”
- The positions of these drifters 1 and 2 weeks later were then plotted
- Drifters originating further north along the peninsula were more likely to move into the Gulf of Mexico or Atlantic



AOI 1	
56 Drifters	
24 retained south of 21N	43%
2 exited the GOM	4%
30 retained in the GOM	53%

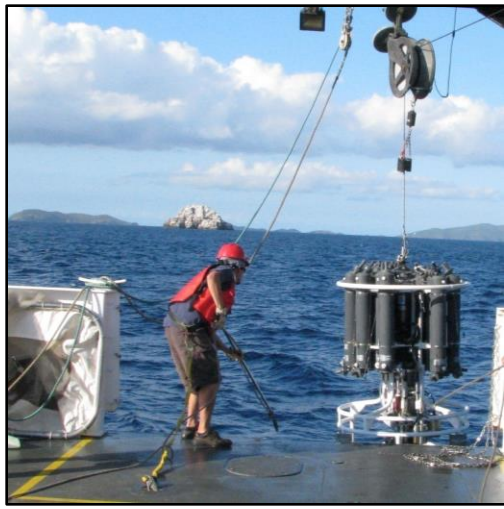
AOI 2	
54 Drifters	
15 retained south of 21N	28%
5 exited the GOM	9%
34 retained in the GOM	63%

AOI 3	
5 Drifters	
5 retained south of 21N	100%
0 exited the GOM	0%
0 retained in the GOM	0%



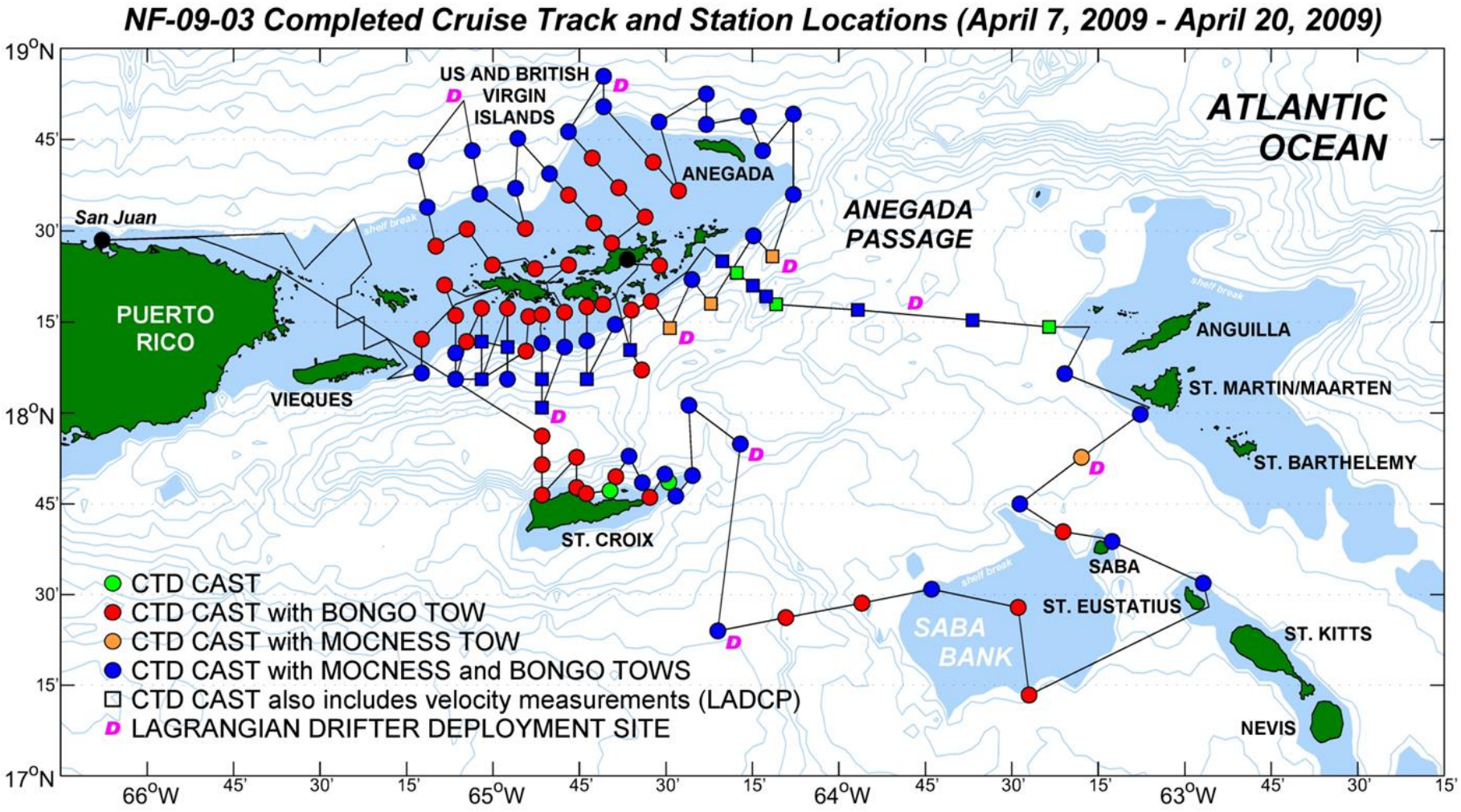
US Virgin Islands Larval Reef Fish Supply Study

- *Aims*
  - To investigate the distribution and abundance of reef fish larvae in the northeast Caribbean, in relation to physical oceanography
- *Time Period*
  - Four annual cruises: 2007 - 2010
  - Inshore sampling: 2007 - 2008
- *What we did*
  - Completed biophysical sampling including
    - Plankton tows for larval fishes
    - CTD casts, drifters and ADCP
    - Inshore light traps for settlement-stage larvae
- *Organizations*
  - AOML
  - SEFSC
  - University of Miami
  - University of the Virgin Islands
  - Virgin Islands Department of Planning and Natural Resources



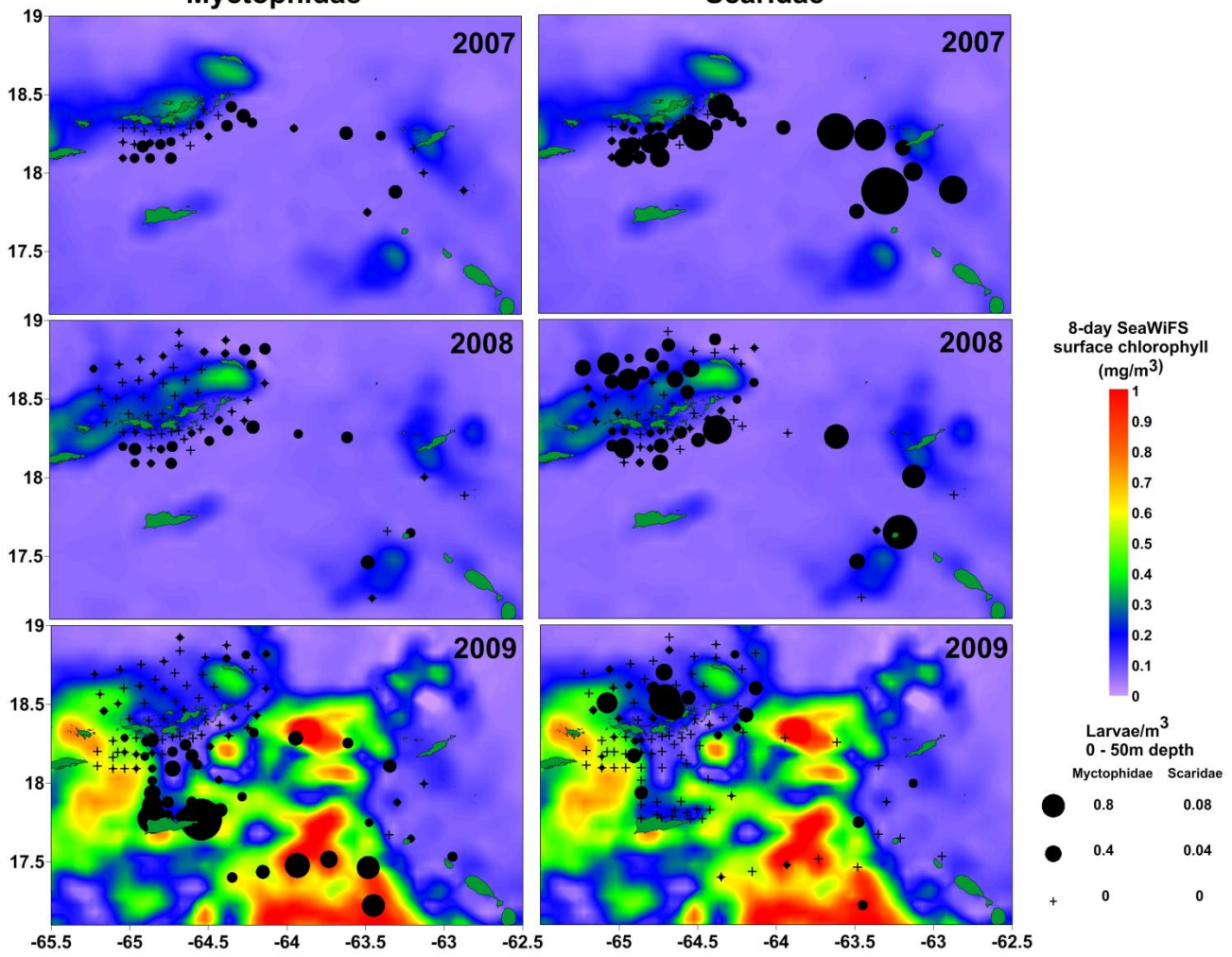
Study area

- Our cruises focused on the northeast Caribbean, centered around the US Virgin Islands
- We sampled shelf and offshore environments in the spring, over a period of approximately three weeks per year



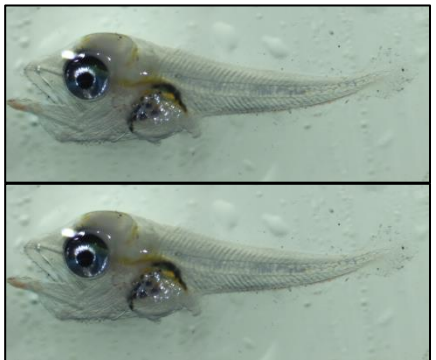
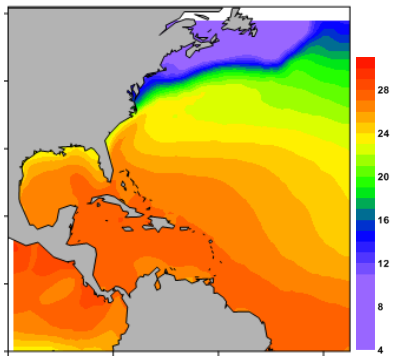
Interannual variability

- We collected larvae of mesopelagic, and reef associated fish species
- During 2009, reef-associated assemblages were largely displaced by a high chlorophyll plume of water originating from the Amazon River outflow (see Johns talk next)



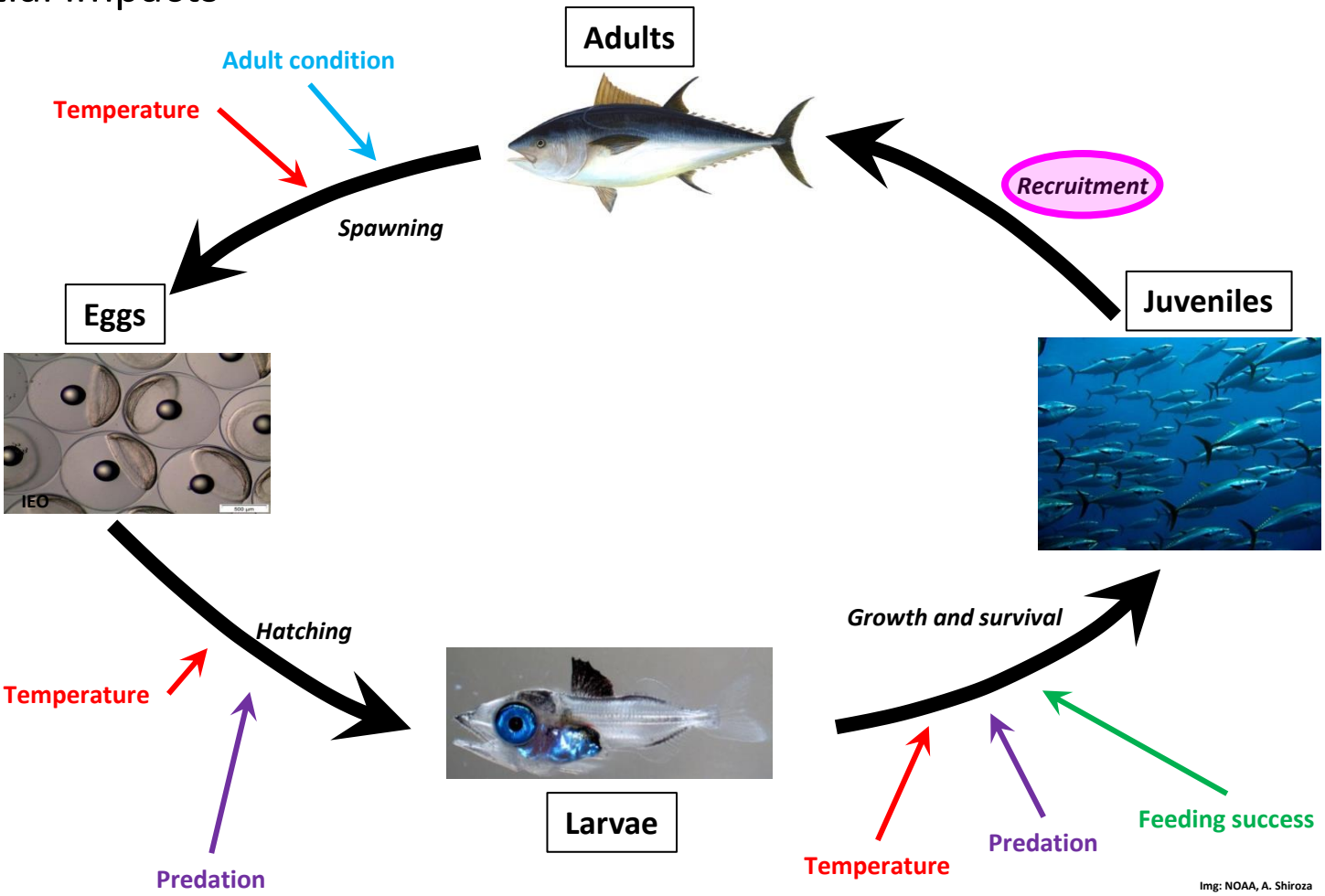
Climate change impacts on Atlantic tunas and billfishes

- *Aims*
  - To use climate and habitat models to examine climate change impacts on Atlantic tunas and billfishes
- *Time period*
  - 2007 - 2015
- *What we did / are doing*
  - Examining catch records and ecology of larval and adult fishes to construct habitat models
  - Applying habitat and ecological process models to projections from a downscaled climate model
- *Organizations*
  - AOML
  - SEFSC
  - University of Miami
  - University of South Florida
  - ROFFS
- *Further reading*
  - Muhling, Barbara A., Sang-Ki Lee, John T. Lamkin, and Yanyun Liu (2011) "Predicting the effects of climate change on bluefin tuna (Thunnus thynnus) spawning habitat in the Gulf of Mexico." ICES Journal of Marine Science 68: 1051-1062
  - Liu, Yanyun, Sang-Ki Lee, Barbara A. Muhling, John T. Lamkin, and David B. Enfield (2012). "Significant reduction of the Loop Current in the 21st century and its impact on the Gulf of Mexico." Journal of Geophysical Research 117: C05039

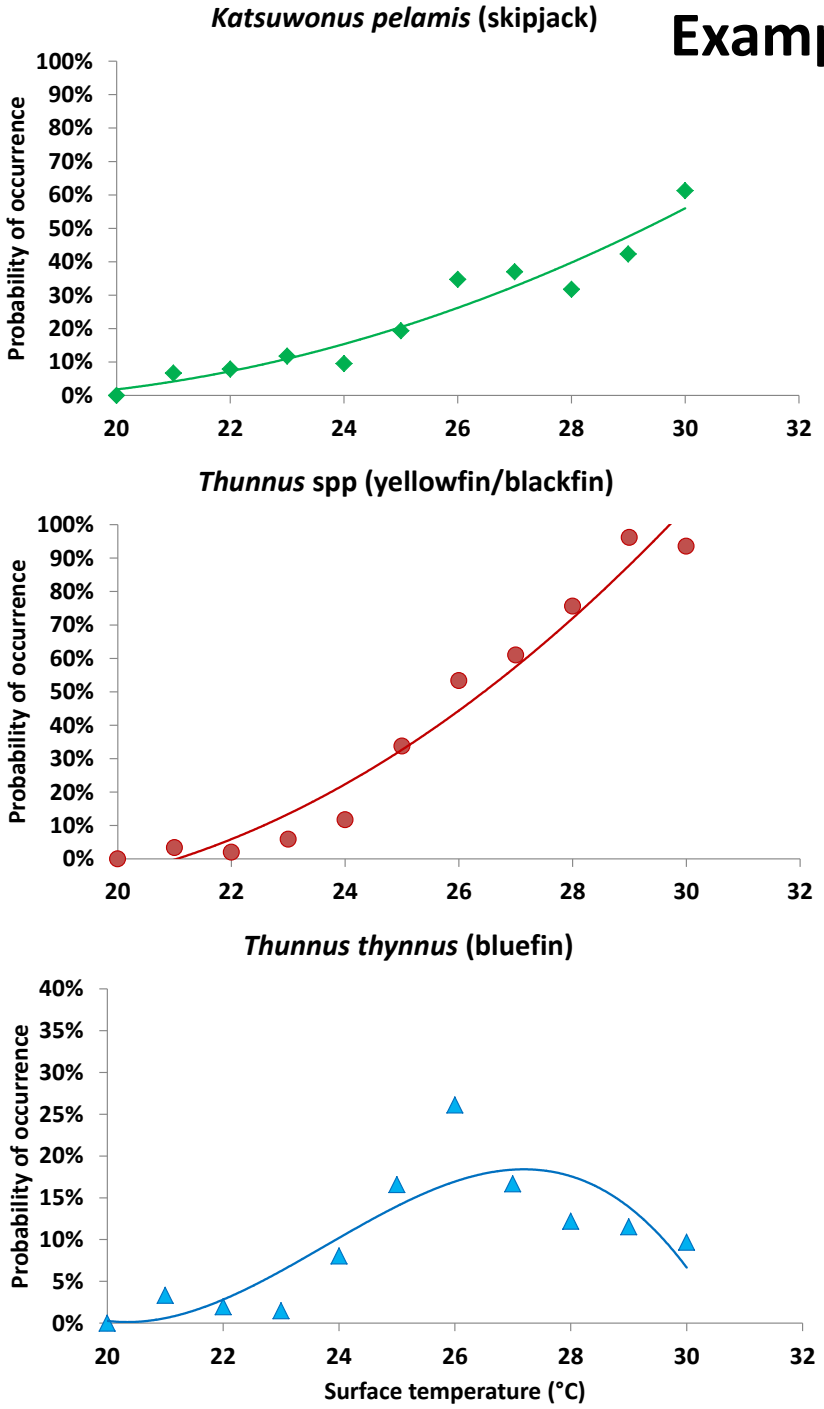




Rationale: Climate, environment and fish life history

- Climate change will influence fish populations through multiple direct and indirect effects
- Survival of egg and larval stages may be critical to recruitment, but is often overlooked
- We are combining models of ecology, distribution and future conditions to assess potential impacts



Example: Tuna larvae and spring temperature

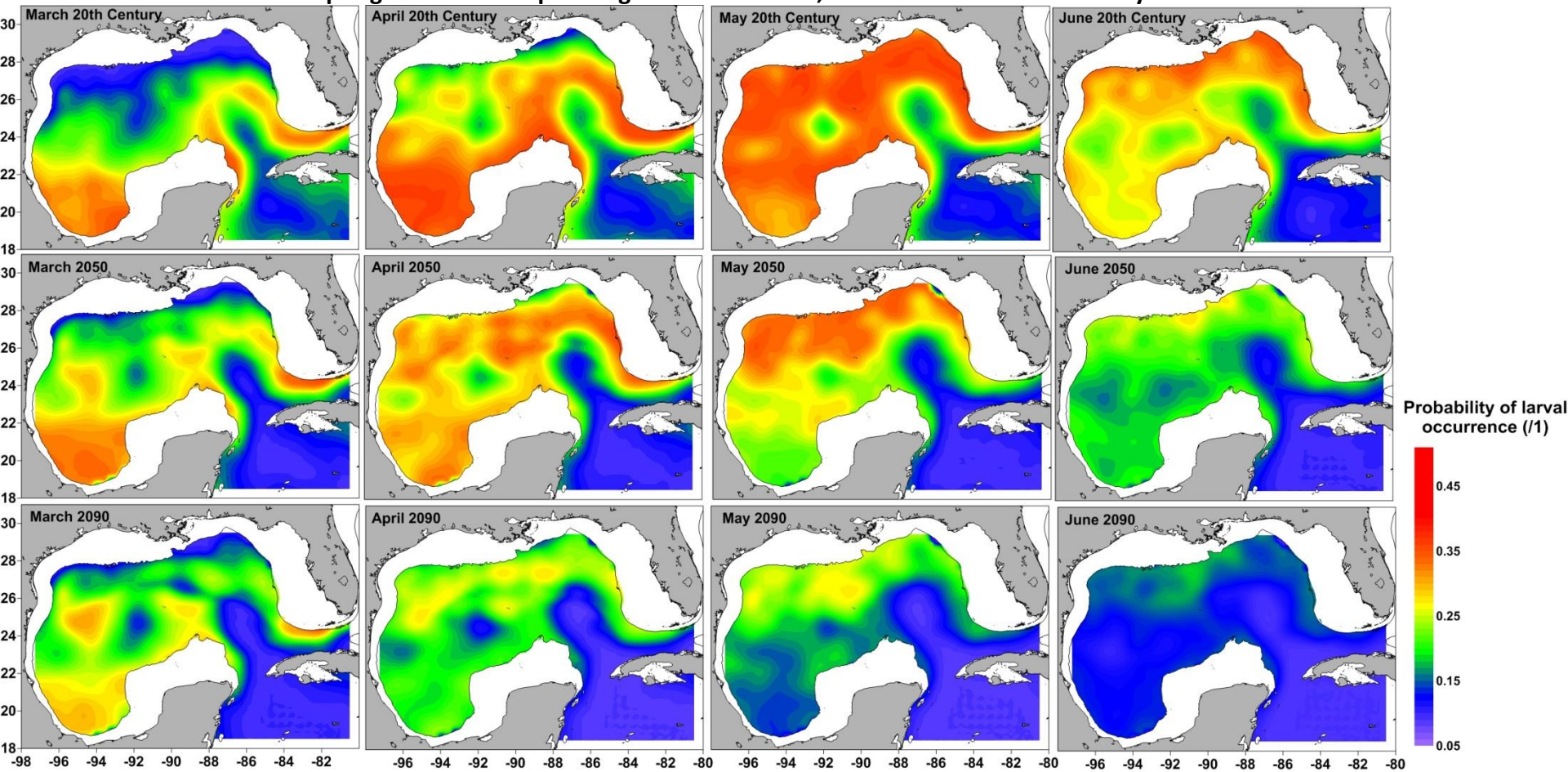


- Bluefin tuna larvae are most abundant at moderate temperatures, reflecting the spring spawning season, and intolerance of adults to high water temperatures
- In contrast, larvae of tropical tunas (skipjack, yellowfin, blackfin) increase in abundance with increasing temperatures
- These species spawn in the warmest months of the year, and are frequently found in the warmest available water
- We used these associations to build spawning habitat models, which were then applied to future temperature predictions, from a downscaled climate model (See Lee and Liu talks)

Predicted bluefin tuna spawning habitat

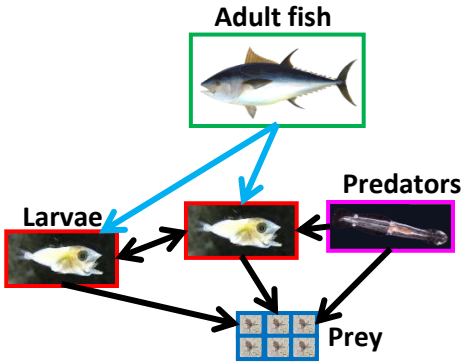
- Bluefin tuna spawning habitat was predicted for the months of March – June for three time periods:
  - Late 20th century
  - Mid 21st century
  - Late 21st century
- Results predict a decline in suitable spawning habitat in the Gulf of Mexico through to 2100

Spring bluefin tuna spawning habitat: late 20th, mid 21st and end 21st century

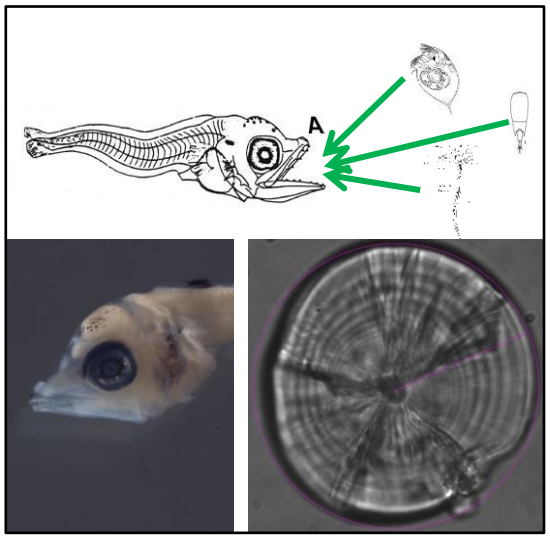


Ongoing work: mechanistic approaches

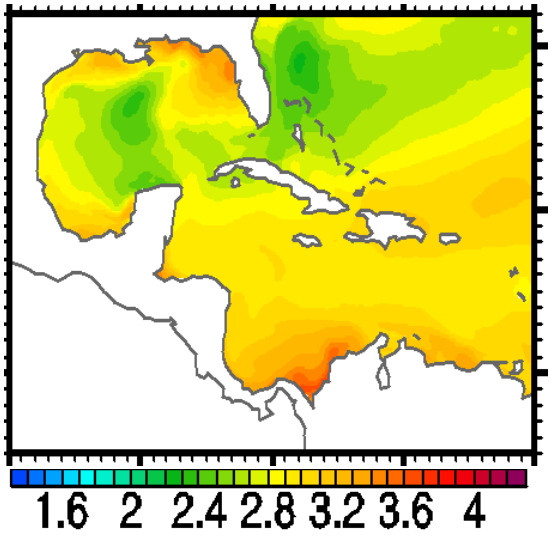
- *Larval age, growth, diets and feeding success* (Estrella Malca, ELH, Joel Llopiz, WHOI)
  - Long-term changes in populations are likely determined by recruitment rather than adult distributions
  - Recruitment is frequently driven by survival during early life
  - We therefore need to improve our understanding of larval ecology
- *Linking ecology to long-term environmental conditions* (Sang-Ki Lee, Yanyun Liu, CIMAS-AOML)
  - Larval growth and survival models built on present-day data will be used to look at the suitability of past conditions (using a 20th century reanalysis), and future conditions (using a downscaled climate model)
  - This will enable us to examine climate change impacts on multiple scales, and life stages, and develop measures of impact and vulnerabilty



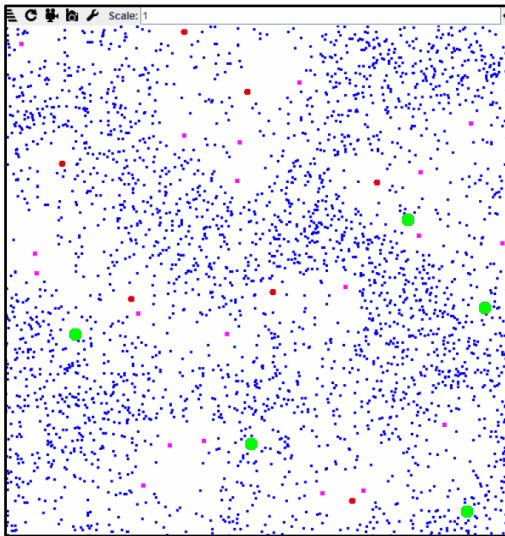
Larval ecology studies



Models of environmental conditions



IBMs and other mechanistic models



Questions?

And thanks to some other folks…

- NOAA-NMFS
  - South East Fisheries Science Centre
    - Early Life History Group
    - Stock Assessment Division
    - Fisheries Statistics Division
  - Pascagoula Laboratory
    - Kim Williams, Joanne Lyczkowski-Shultz
    - David Hanisko, Denice Drass, Walter Ingram
- NOAA-AOML
    - Nelson Melo
    - Grant Rawson, Rick Lumpkin
- University of Miami
  - Andrew Bakun, Josefina Olascoaga
- University of South Florida
  - Sennai Habtes
- ROFFS Ocean Fishing Forecasting Service
  - Greg Gawlikowsi, Matt Upton
- The University of Southern Mississippi
  - Jim Franks, Bruce Comyns
- The University of South Carolina
  - Joe Quattro, Mark Roberts
- INAPESCA Mexico
  - Karina Ramirez
- IEO Spain
  - Francisco Alemany, Alberto Garcia, Raul Laiz
  - Patricia Reglero, Diego Alvarez
- Plankton Sorting and Identification Center, Szczecin, Poland
- Marine Geospatial Ecology Toolbox – Duke University
  - Jason Roberts
- NOAA Ships Nancy Foster and Gordon Gunter
- R/V F.G. Walton Smith